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Role of science in ecosystem management

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Abstract

Roberts argues that in order to implement ecosystem management, resource management must switch its ecological perspective from an individual- and population-based focus to ecosystem- and landscape-based ecology; from an "object" (form) to "context" (function) approach; and adopt a multi-scalar modelling approach. A major role for science in EM is to predict ecosystem behavior under alternative management strategies. Wilcox, Risbrudt, Thomas, and Kessler all emphasized the critical role of a higher level of science, although Daniels pointed out that there is a risk of creating a politics of expertise. Thus participating scientists have a strong responsibility to communicate their knowledge to the public in understandable ways.

Clearly ecosystem science has an important role to play in the development and implementation of ecosystem management in the Intermountain West. However, because ecosystem management includes a diverse array of players with differing perspectives, exactly what role science will play varies with those perspectives. This paper examines the role of science in ecosystem management as portrayed by the speakers.

At one end of the spectrum, some speakers argued that science should provide the most basic foundation for ecosystem management.

Ecosystem management, as portrayed by the ecosystem ecologist Dave Roberts, was described almost entirely in terms of ecological science. Roberts advocated ecosystem management as an ecological procedure: managing ecological components and processes to achieve and sustain ecological systems while maintaining protection for human use. Roberts' general definition of ecosystem management is different from others at the conference in that it emphasizes ecological science above social and political factors. He does not maintain this is how the paradigm will be implemented, but simply argues what ecosystem management would entail from a purely scientific point of view.

Roberts contends that ecology has long been involved in resource management, but that EM requires a change in the branches of ecological science playing a role. He maintains that the key difference from an ecological perspective between traditional management and EM is the shift from population- and individual-based ecological work, which traditionally dominated forest-management decisions, to ecosystem- and landscape-based ecology. The individual and population approaches were used to maximize production, but landscape, ecosystem, and conservation ecology are all crucial for implementation of EM.

Roberts showed that there have been two main perspectives in the study of ecosystems which have led to confusion when not clearly distinguished. These perspectives are object and context approaches to studying ecosystems. Large differences in management strategies can result, not from large differences in objectives, but simply from differences in how an ecosystem is viewed. The object view considers ecosystems as mappable areas which can be defined. This has been the traditional approach taken by land managers as ecosystems are first mapped, and then management strategies are implemented to achieve desired future conditions. In contrast, the context view considers ecosystems as the combination of all ecological processes taking place, with each process having its own temporal and spatial scale. Thus there are no readily apparent ecosystem bounds since processes take place on a variety of scales. In addition, ecological processes are what are managed, not the ecosystem itself.

Although Roberts argued that ecology has a large role to play in ecosystem management, the role of ecological science has a different focus than it traditionally has had. He believes that ecological science should design management systems which don't emphasize any particular thing to manage for, but instead emphasize the *range* of potential conditions that can be

managed. In addition, science should predict what the future behavior of systems will be in response to management strategies.

Roberts argued that a multiscalar approach can help in the implementation of ecosystem management by examining each organism or process at the correct scale, and interlacing models to get a dynamic picture of ecosystem changes. This approach to ecosystem management also requires new mapping procedures. GIS and the associated algorithms are the future for ecosystem management. Although ecosystem management definitions are vague, the key scientific focus in ecosystem management should be on maintaining and sustaining ecosystems.

The modeling approach advocated by Roberts is a scientifically sound procedure. However, it requires large amounts of information which are not currently available in most cases. This approach assumes that we have the data to make the decisions. Some ecologists, however, advocate an alternative scientific approach which is formulated on the basis that nature is too complex and our understanding of ecosystems is incomplete. Since decisions must continually be made by resource managers, some ecologists such as Winifred Kessler argue that adaptive management is a procedure for making decisions while still advancing our ecological understandings of ecosystems.

Louisa Wilcox, representing the Greater Yellowstone Coalition, also made a strong case for the importance of science. She defined ecosystem management as "that which maintains the integrity of ecosystems, their energy flow, trophic structure, biodiversity of species, and material cycles as well." This definition clearly suggests a vision of ecosystem management based almost entirely on ecosystem science, where social and economic concerns are of secondary importance. Under this vision, ecosystem science and conservation biology provide both the blueprint for future landscapes and the means for achieving that landscape.

For the majority of symposium speakers, and especially those representing federal agencies, ecosystem management meant integrating ecosystem science with sociology and economics. Chris Risbrudt may have most clearly communicated the integrated viewpoint. He provided the Forest Service's four guiding principles of ecosystem management: (1) ecosystem management is an ecological approach to the management of national forests and grasslands, (2) the best scientific information available will be used for decision making, (3) agency partnerships are essential, and (4) public participation should occur at all levels. This definition suggests that community needs will be recognized by drawing products from the land, but that science will play a large part in determining how these products are drawn. Under Multiple Use Sustained Yield (MUSY) management, impacts have typically been assessed at small spatial and temporal scales, often resulting in unpredicted cumulative, landscape-level changes that have disrupted ecosystem function. Under ecosystem management, the principal function of the ecosystem-science disciplines, especially landscape ecology and conservation biology, will be to maintain ecosystem integrity, as well as the natural range of variability and diversity. In this view, understanding the dynamics of natural ecosystem variation, and how this can be integrated with resource management, are the greatest challenges facing ecosystem science.

Jack Ward Thomas recognized that the ideals behind ecosystem management have been around since Leopold's *Land Ethic*, but until now the technology of ecosystem science was incapable of making these ideals feasible. Dave Roberts provided an excellent example of how these new ecosystem-science disciplines might contribute to Thomas's vision of ecosystem management. Thomas also suggested that ecosystem management will force the evolution of a new specialty that synthesizes scientific information for decision makers.

Winifred Kessler indicated that the complex issues generated by ecosystem management will force both managers and the public to develop a new perspective on how resources are managed. Kessler argued that the only way to successfully manage landscapes which are prone to unpredictable changes is through adaptive management, or "learning by doing." Consequently, under her view, science can contribute to management in two ways: through providing information about the ecosystem and through conveying understanding of the scientific method and experimental learning to resource managers.

For many symposium participants, the role of science in ecosystem management is primarily educational. For these speakers, politics and economics are the primary drivers of resource management. Consequently, the principle role of science is to educate managers and the general public, so that the most ecologically sensible resource-management decisions will be made. Steven Daniels contended that applying the best science created a politics of expertise, which provided social legitimacy for ecosystem management. However Daniels also warned that the politics of expertise could lead to exclusion of the people affected by management. To solve this paradox, he maintained that scientists must communicate their knowledge to the public, preferably through a collaborative-learning process. Jack Stanford provided an example of how science can be conducted to provide information for making decisions, and Brett KenCairn and Doc and Connie Hatfield provided examples of how scientists should interact with the public for optimal planning.

For some symposium participants, however, ecosystem science may in fact be irrelevant to the success or failure of ecosystem management. George Coggins clearly indicated that the biggest challenges to ecosystem management will be in the courtroom, not in the laboratory. Because ecosystems cross cultural and political boundaries, Coggins argued that a legal mandate will be absolutely essential if ecosystem management is to succeed.

Clearly, ecosystem science will have many roles to play under ecosystem management. Ecosystem science will help determine how and what resources can be drawn from the landscape. Ecosystem scientists can also provide information to the public so that ecologically appropriate decisions are made. While political science and economics may shape ecosystem management as a policy, ecosystem science will in the end determine whether this new paradigm is the most appropriate way to manage the land.